AN INTRODUCTION TO THE ARCC CLIMATE CHANGE AND WATER RESOURCES IN WEST AFRICA SERIES

CONTEXT

The complex interactions that affect the climate in West Africa make it difficult to predict, with exactness, the impacts climate change will have on the water resources of the region. Most climate model projections agree that temperatures will increase over the next 35 years, but estimates of the level and rate of change vary. Projections differ even more regarding changes in precipitation, but it appears likely that rainfall will become less reliable and more variable, with increases in extreme events.[1]

These changes in temperature and rainfall will likely have negative effects on the availability of groundwater and surface water, and thus create challenges for the equitable allocation of water in transboundary river basins. Rising sea levels, stronger storms, and higher storm surges associated with climate change will negatively affect coastal populations and natural resources, especially in low lying areas. The Africa and Latin America Resilience to Climate Change (ARCC) project prepared four reports to explore the impacts on groundwater, transboundary watersheds and coastal areas.[2]

Groundwater. Rural populations in West Africa rely heavily on groundwater resources to sustain themselves and their economic activities. The majority of that groundwater is stored in the large, near-surface sedimentary basins of the major rivers, or in deeper, non-renewable reservoirs. Demand on groundwater resources has increased significantly since 2001, primarily because of growing populations and efforts to achieve the Millennium Development Goal for drinking water, which has expanded the

[1] "*Background Paper for the ARCC West Africa Regional Climate Change Vulnerability Assessment,"* (Baptista, S., Brottem, L., de Sherbinin, A., Edquist, M., Fischer, A., Levy, M., Schnarr, E., Simon, C., Sundareshwar, P.V., and Trzaska, S. USAID, 2013).
[2] "An Assessment of Groundwater Management in West Africa in Light of Climate Change," (Murray-Rust, D.H., & Fakhruddin, S.H.M., USAID, 2014): "Transboundary River Basins in West Africa in Light of Climate Change," El Vilaly, A., & El Vilaly, M.A., USAID, 2014); "Mapping the Exposure of Socioeconomic and Natural Systems of West Africa to Coastal Climate Stressors," Center for International Earth Science Information Network (CIESIN), de Sherbinin, A., Chai-Onn, T., Jaiteh, M., Pistolesi, L., Schnarr, E., & Mara, V., USAID, 2014; and "West African Coastal Vulnerability to Climate Change: Biophysical and Institutional Analysis," Badjeck, M.-C., Bohn, B., & Sommerville, M., USAID, 2014.

use of boreholes and hand pumps. Changes in the availability of surface water owing to climate change will likely increase the demands on groundwater further.

Transboundary River Basins. West Africa has 11 major river basins that cross national boundaries. Hence, much of the water resources of individual West African nations originate outside of their national boundaries, which makes equitable resource allocation and cooperation between upstream and downstream nations a major concern. This cooperation can be accomplished through transboundary river basin authorities. Five such authorities currently cover the five largest transboundary basins in West Africa.

Coastal Vulnerability. Most of West Africa's population lives along the coast, mainly in rapidly growing urban areas. The coastal area is also home to many sensitive natural environments. Rising sea levels and more frequent and more intense storms will put many people — and significant economic and natural assets — at risk. Changes in fish migratory patterns and increased coastal erosion will directly affected many of the most vulnerable along the coast. Adapting to these challenges, as well as those posed by urban growth, the growing demand for resources, and the difficulties inherent in carrying out and enforcing land use planning, will require a whole of government approach as well as international cooperation. Given the size and complexity of the coastal zone, mapping the areas that are potentially vulnerable to climate change risks — and understanding the current state of ecosystems, inhabited areas, as well as the possible future climate scenarios — can provide direction for development and planning.

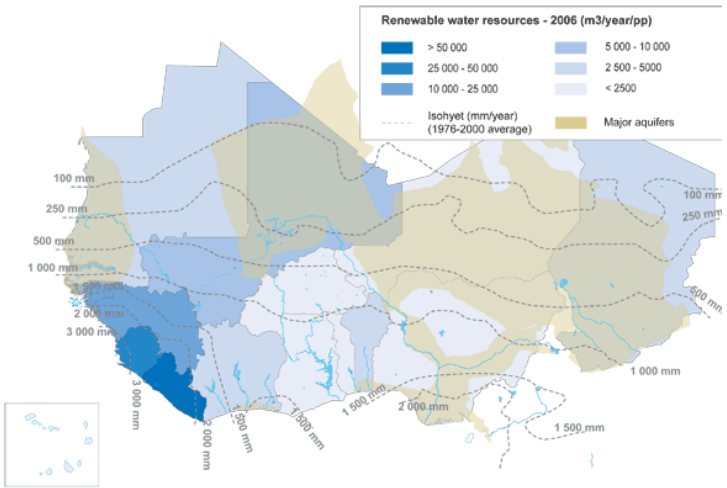
FINDINGS

Groundwater. West Africa's groundwater resources are threatened in a number of ways. First, the predicted rise in temperatures and changes in rainfall patterns due to climate change are likely to reduce recharge of the aquifers while at the same time increasing the demand for this resource owing to less reliable surface water resources. Second, population growth projections indicate that about twice as much drinking water will be required in 25 years, with the highest needs for urban populations. Third, the increasing promotion of powered wells, particularly on large commercial farms, would put a high degree of added stress on the region's non-renewable aquifers.

Unfortunately, it appears that current water management initiatives mainly consist of national dialogues and often do not reach the local level, where water is actually used and managed. The databases that do exist are generally kept by national institutions and are not available to those who manage water. Institutional capacity to manage water, especially at the sub-national and local level, is generally weak.

Murray-Rust & Fakhruddin (2014) argue that sustainable management of groundwater resources will require an Integrated Water Resources Management (IWRM) approach. IWRM seeks to manage both surface water and groundwater supplies together in a

MAJOR NON-RENEWABLE AQUIFERS AND RENEWABLE WATER RESOURCES IN WEST AFRICA



holistic manner while also seeking to balance the demand and supply of water. IWRM is participatory process that cannot be left solely to government departments and agencies. Users must be actively engaged to help define management targets and regulate and police water use. Effective management systems will be needed to create a stable production system that has the capacity to respond to threats, including those posed by climate change.

Transboundary River Basins. Over the past half century, the water supply within most of the major rivers in West Africa has declined. The reason for this decline is a complex mix of changes in climate (e.g., rainfall), changes in land use and land cover, and population increases. Therefore, while studies based on climate projections alone suggest river flows could decline by another 20-40 percent by 2050, the actual amount of change in the future is uncertain and will depend on the complex interactions of multiple factors.

Increases in water stress associated with decreases in water supply will affect a number of important sectors along rivers, especially agriculture and fishing. Climate change will alter value chains involving these sectors by disrupting production and processing cycles, thus creating obstacles to market access and producing price fluctuations. Among possible impacts, declines in rainfall and increases in temperatures may result in declines in primary fish production and yield, while flooding may impede transportation to markets. Climate variability and change may also contribute to the dislocation of populations that depend on rivers and their water basins, possibly transferring climate stresses to other regions of West Africa.

People have begun to adopt a variety of adaptation and coping measures to address these impacts. These measures differ depending on socioeconomic, political, and environmental factors. They also involve trade-offs and may result in impacts on water supplies now and in the future. Effective, equitable and sustainable adaptation at the local level will require governmental support as well as complementary efforts by international institutions to coordinate the management of water resources by national governments. El Vilaly and El Vilaly (2014) assessed the capacity of the five transboundary river basin authorities to provide this coordination. While it was impossible conduct a complete and rigorous assessment purely based on literature, the study argues that each authority has both strengths and weaknesses in relation to addressing climate change, and that all of these authorities would benefit from the support of donors, governments, and their partners. However, additional, on-the-ground research is necessary to identify the exact needs and capacities of each organization.

Coastal Vulnerability. About 19 million people live in areas that are less than 10 meters above sea level along the coast from Guinea Bissau to Cameroon. This area, particularly from Ivory Coast to Nigeria, is undergoing rapid and intense economic development that could be affected by changes in the coastal climate, such as sea level rise and increases storm surge. By mapping the threat to sea level rise, de Sherbinin, Chai-Onn, Jaiteh, Pistolesi, Schnarr, & Mara (2104) show that the Niger Delta in Nigeria is at particularly high risk given its low elevation. The exposure risks are somewhat lower from Guinea to Liberia, where the coast rises more steeply. Owing to the geology of their coasts, the risks from sea level rise in Ivory Coast, Ghana, and Togo lie somewhere in between.

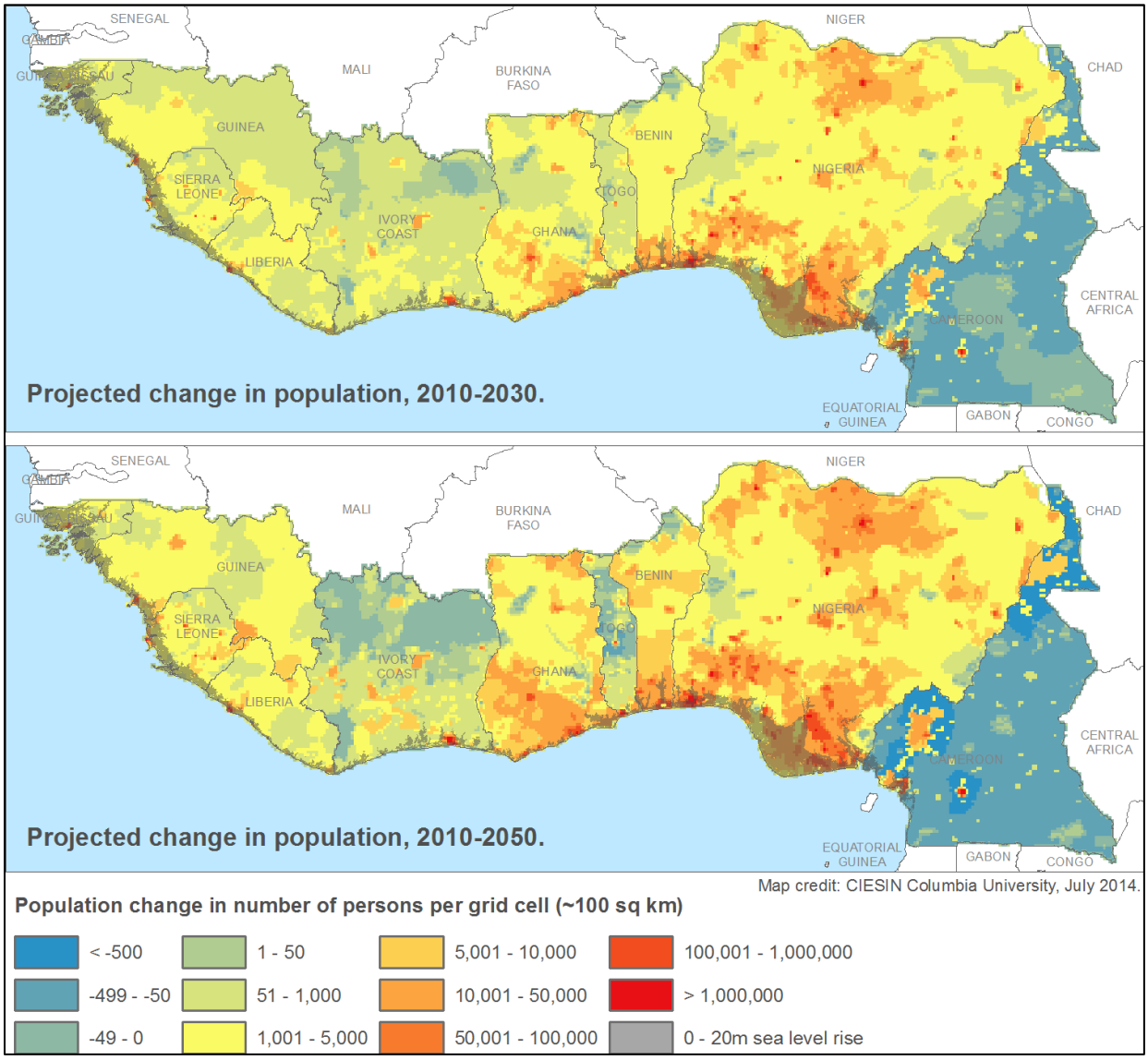
After assessing exposure to sea level rise, de Sherbinin et al. (2014) uses data for population density and growth, poverty levels, maternal education levels, market accessibility, and conflict to map a measure of social vulnerability in a 200 kilometer band along the coast. Based on this measure, the Niger Delta and Lagos are "hotspots" of social vulnerability and Conakry (Guinea), Freetown (Sierra Leone), Accra and Cape Coast (Ghana), Cotonou (Benin), and Douala (Cameroon) are also found to be highly vulnerable.

Using data for GDP, highly urbanized areas, and the production of high-value export crops, the study then maps a measure of economic vulnerability. The results show that the Niger Delta, Lagos, and

Cotonou are highly vulnerable, with just slightly lower levels of vulnerability in Lomé (Togo), Accra, Abidjan (Ivory Coast), Monrovia (Liberia), Freetown, and Conakry. de Sherbinin et al. (2014) also shows road networks at risk of flooding, with the inundation risk highest in Sierra Leone, followed by western Ghana, coastal Togo and Benin, and Lagos. Data on ecological resources — mangrove forests, forest cover loss, wetlands, and threatened species — are also mapped. Currently, protected areas are few and relatively small; significant additional efforts will be necessary to protect these natural systems. Mangroves are of special concern. They lie in the exposure zone and are highly vulnerable.

Research and Institutional Challenges. While it is impossible to generalize about particular vulnerabilities across the varied ecologies of the West African coast, there are some threats that should be of special concern to policymakers. These include increasing coastal erosion and loss of wetlands, negative impacts on fisheries and croplands, and increasing risks to infrastructure and populations in urbanized areas.

PROJECTED CHANGE IN COASTAL POPULATION FROM 20102-2030 AND 2010-2050



Badjeck, Bohn, and Sommerville (2014) note that although coastal erosion is influenced by a number of factors, it is likely to increase as sea levels rise. While knowledge gaps exist regarding the characteristics and origin of the coastal geology and about coastal assets that might be affected by erosion, a new littoral observation network in West Africa that is being developed should help further understanding of this vulnerability. Better modeling of these ecosystems, particularly for the river deltas, can help us understand how climate change will interact with growing populations around them.

While the general effects of climate change on fisheries are understood, there is little scientific evidence on the specific impacts that may occur. For example, it is not known if the migratory patterns of fish will shift in West Africa. Researching these impacts is important because changes in coastal fisheries have the potential to severely undermine food security in individual countries and throughout West Africa. At the same time, these studies, while important in themselves, need to be complemented by efforts to increase regional coordination and enforcement of laws opposing illegal, unregulated, and unreported fisheries. This will be necessary to address the full range of issues certain to affect coastal fisheries.

Each of the urban areas identified in the mapping assessment has unique physical and socioeconomic characteristics that determine its vulnerability to climate change. While urban areas generally have more resources to use for adaptation, even these increased resources may be inadequate to the task if major infrastructures are threatened or if the rate and magnitude of change outstrips the ability of populations to adapt. As most countries have only a single large city on the coast, regional collaboration on the lessons of urban planning in the face of a changing climate will be needed.

While the needs for coastal adaptation are huge, no single institution in West Africa currently has all of the capacities — or the mandate — to address the range of issues associated with climate change. Hence, existing institutions will need to work in collaboration across national boundaries to share knowledge and experience. Unfortunately, this coordination is hampered by the large number of regional and national institutions that gather and manage information relevant to climate change adaptation and coastal management. The relationships between those institutions that generate information and those that influence policy and its implementation are of particular importance. At the regional level, several institutions have the mandate to support policy development and coordination within the coastal zone, but their teams are typically small, underfunded, and overstretched. Within national governments, climate change is typically assigned to the environment ministry, which often struggles to influence the wide range of sectors with coastal interests.

RECOMMENDED ACTIONS

For Groundwater

- IWRM could be implemented in West Africa using the Multiple-Use Services model that has been piloted in Niger.
- An IWRM component should be added to agriculture and food security programs to ensure water, agriculture, and human development are properly integrated.

For Transboundary River Basins

- Further research is needed to clarify the causal relationships between climatic conditions and water supply. This research should include studies on the relative influence of climate change as compared with other non-climate factors such as population growth, increased demand for hydropower and irrigation, and changes in land use.
- To better understand their institutional capacity, further research is needed on all five river basin authorities. Follow-up research is also needed on threats to water resources in smaller

transboundary river basins, such as Tanoé and Cross, and the Fouta Djallon Mountains of Guinea, where 5 of the 11 basins have their source.

- The capacity of Transboundary River Basin Management Institutions should be supported and encouraged to collaborate with one another to adaptively co-manage transboundary basins; to respond to the dynamic needs of local populations; to predict, monitor, and respond to climate variability and extreme events; and to address root causes of water stress related to human activity.

For Coastal Vulnerability

- Priorities for engagement on coastal zone adaptation in West Africa include: large urban centers, mangrove areas, climate information and services, and coastal fisheries. For example, future research could focus on urban vulnerability assessments and processes to integrate climate change into urban planning to help reduce future risk to infrastructure and populations.
- Research is needed into the possible effects on mangroves, and this research could fit into the existing Mangrove Charter and National Action Plan for West Africa. Regional collaboration could be achieved through the Food and Agriculture Organization or the Abidjan Convention Secretariat.
- A community of practice needs to be developed among the various institutions mandated to study climate effects on the coastal zone to better coordinate activities and liaison with policy making entities.
- A priority for further mapping is to refine the analysis for the areas of high risk, particularly for Nigeria and the Niger Delta. This should be possible using existing frameworks and assessment tools along with improved data.
- Another priority is development of an interactive tool decision makers can use in planning for coastal climate adaptation. The decision-support tool should put in place an iterative process that examines how risks, responses, and results link up across multiple sectors, jurisdictions, and stakeholder groups.

Taken together, these studies serve to illustrate a number of high-level conclusions, which are, in turn, reinforced by the larger body of ARCC work. Research into the vulnerability of the region's water resources requires a broad perspective, one that takes into account the complex interrelationships among development issues that impact — and serve as the context for — the management and use of the region's water resources. The studies make clear that effective support to climate change adaptation in West Africa will require significant advances in the collection, analysis, and distribution of relevant information — especially, but not exclusively, climate information. These documents also contribute insights into the design and use of methods, and highlight priorities for future research. They identify lacuna in the available literature, as well as potential vulnerability hot spots where additional research will be critical. Nevertheless, the four studies of the ARCC West Africa water resources series provide actionable information useful to developing integrated strategies to help the region's governments and their partners determine how to adapt to the effects of climate change.